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XXXVIII.—*On the Amber Beds of East Prussia.* By Dr. K. THOMAS*. Communicated by the Rev. M. J. BERKELEY, M.A., F.L.S.

THE lignite (Braunkohle, Bovey-coal) which occurs on the East-Prussian shore of the Baltic has, in consequence of Dr. Albrecht's recent discovery of the value of the strata, attracted lately more general attention. This induces me to speak of a subject, which is no longer invested with a merely scientific interest, less with a view to question its mineral value, which may I hope prove highly remunerative, than to direct the interest which has been excited to a point, which hitherto has received too little attention in these districts. It is at present a generally received notion, that the surface of East Prussia and the neighbouring provinces was formed of the confused fragments of formations which were torn from their original position by the last deluge which determined the modern condition of the continent. A district of this nature can have merely a subordinate interest for the geologist, and the miner will scarcely search there for the more precious or other metals, or for the fuel which the bounteous hand of nature so frequently deposits in their neighbourhood. Once only about the middle of the last century the salt-springs, which occur in the jurisdiction of Pregel, gave occasion to a tolerably complete investigation under the conduct of the Prussian minister Von Heinitz, from which it appeared that no further mining exploits could reasonably be undertaken in this district; but thus much at least was established, that the north-western point of Samland, on which the lighthouse of Brusterort is now situated, belongs to the tertiary strata, which stand forth there in a remarkable manner like an island, from

* From the Number for April 1847 of Die Ostpreussischen Provincialblätter.

the diluvial mass of the plain which extends from the Carpathian mountains. As such it is represented in the older geological maps of Germany. A threefold deposit of blue clay and white sand characterizes the formation; whether the occurrence of marine remains of an extinct world, which could scarcely have escaped the eye of an attentive observer, would have established its tertiary character, may in the absence of proper information be the rather neglected, since it is not my object to write a learned treatise. Little attention has been paid to them, and in the most recent work* which has touched expressly on the geological relations of the amber districts, they have been altogether neglected, and in fact, like the lignite which occurs near the amber, regarded merely as its accidental attendants.

Fossil wood, both perfectly petrified and in a peculiar state of decomposition from exposure to the weather, is so frequent on this coast, that it cannot have escaped observation. The continual changes to which the coast is exposed, from the influence of atmospheric variations, often bring to light enormous trunks of trees, which the common people had long regarded as the trunks of the amber-tree, before the learned declared that they were the stems of palm-trees, and in consequence determined the position of Paradise to be on the coast of East Prussia. Some years since a fir-branch with well-preserved cones was said to have been found in the Hubenik amber-tracts, together with palm-nuts, for which the fossil fruit of a kind of walnut was mistaken; this however, to the regret of the scientific, has so completely vanished, that its existence might almost be considered a fable. I was therefore the more surprised when, in the summer of 1829, I found two well-preserved fossil fir-cones in the hills along the coast at Rauschen, which the rain had washed out of their natural position. Although they were regarded, by those of my neighbours whose opinion was asked, as recent fir-cones, which may have been derived from the forests which formerly clothed the shores, I was myself, in consequence of their peculiar appearance, far from convinced of this, and I applied with fresh zeal to the investigation of the locality when I returned after many years' absence. Continued researches were soon rewarded with a collection of fossil cones, which for number and beautiful state of preservation would have graced any collection. I convinced myself besides most clearly, that the line of coast from Lapöhn beyond Rauschen, Georgswald and Warnik almost to Grosskuhren consists of regularly alternate beds of blue clay and white sand running parallel with the surface of the sea,

* Die im Bernstein befindlichen organischen Reste der Vorwelt herausgegeben von Dr. George Carl Berendt, in Com. d. Nicolaischen Buchhdlg. Berlin, 1845.

of which the former contains nest-like patches of lignite. This peculiar disposition of the lignite seemed to preclude all hope of profitable works, especially as the absence of every trace of it in those parts of the district of Samland with which I was well acquainted indicated a rapid descent of the strata towards the south. The occurrence too of alum was remarked, and the active process of the efflorescence of clay containing sulphuric acid and salts of iron which nature carries on on the precipitous coast, where the pyrites which occurs in the beds of clay is exposed to the action of the weather. But the present depressed price of alum affords no encouragement to any new works, especially as they must be commenced, if at all, on a large scale.

The scientific interest however arising from this newly-discovered deposit of fossil vegetable remains is far greater than their importance in an industrial point of view. The almost horizontal position of the coal-bearing beds, and the high state of preservation of many of the vegetable remains, confirm the supposition that their original locality cannot be far distant. Amber was long since recognized as the resin of a Conifer, and *Coniferæ*, judging from the remains now extant, must have formed the principal part of the adjacent flora, and many pieces of fossil wood occur, which when moderately heated give out a decided smell of amber. Nor ought it to be matter of surprise that the coal-bearing beds but seldom contain amber, if we reflect, that in all probability these beds owe their formation to some alluvial process, and if so, that the masses of amber from their different specific gravity would find a different resting-place. It is well known that the principal amber-beds, which under the name of Amber-earth crop out to the right and left of the coal-bearing strata above the level of the sea, sink so deep at the places under which the coal-loam extends, that they cannot be worked profitably. As will be shown in the sequel, this amber-earth forms an actual member of the tertiary amber-formation of which these coal-bearing beds may be considered as the alluvium. These cliffs, rising a hundred feet or more above the level of the sea, seldom suffer much from the waves, since they are protected by the natural trending of the coast-line, which runs far into land, from the swell produced by continued north winds. The flat shore at the Kranzer inlet is very much affected. The steep coast on the contrary, commencing at Lapöhn, suffers from the rains which annually wash down what the frost of winter has loosened. As the sea constantly plays on the fallen fragments, the cliffs remain much in the same condition, with the exception of their annual decrease. This waste, which is at about the rate of three feet every year, and will in sixty years throw down the Brusterort lighthouse unless artificially sustained, must act

with peculiar energy to the destruction of the western shore of Samland, where it is matter of history, that a tract of land* a mile broad has disappeared near the ruins of Adalberts chapel, which now stands close to the sea. If then we suppose that in yet earlier times the tract which is now covered by the East Sea, was towards the north not so closed to the present Frozen Ocean, that the currents of the Atlantic could not penetrate, it appears not improbable that a still more rapid destruction of land may have then taken place. What remains cannot be regarded as the shore of a retreating sea, but rather as a great expansion of a formation, of which a part, up to the present north coast of Samland, is exposed to view by a partial elevation of the land. The small plots of land which, under the name of the low grounds (Nehrungen), separate the mouths of the streams of this district, the Weichsel, the Pregel and the Memel, as great inland lakes from the sea, appear to me to be regarded improperly as mere dunes; they intimate rather, by their coast projecting into the sea, the course of those fragments of the formation which could not pass off, and allow us to recognise in the basin of water left behind them, their sinking towards the south and east. The moving sand, which is the sport of the winds on their summit, is scarcely to be regarded as the rejectamenta of the sea, but rather as an actual element of the formation, like the loose sand on the north coast of Samland, which arises from its torn-up strata.

But it is time to return to the lignite which accompanies those strata. The small degree of interest which these objects excited on the spot, and the consequent impossibility of finding any information there as to their true import, induced me to send the whole of the fossil vegetable remains to Professor Göppert of Breslau, who has the most intimate acquaintance with the fossil flora. I neglected not to send written notes of the observations which I had made as to the circumstances under which they occurred. He submitted them to a thorough examination, the results of which were communicated to the work of Berendt above quoted. He gave his decided opinion, that of the fragments of Conifers, two, belonging to *Pinites sylvestris* and *Pinites Pumilio*, remind one so exactly of the now existing forms, that they cannot be distinguished from them; the others, which formed far the greater portion of the collection, gave rise to the species *Pinites Thomasianus* and *Pinites brachylepis*, forms which do not now exist. The perfect agreement of all these remains in their fossil appearance and origin left no doubt as to their being really fossils. But the question, whether the flora to which they owe their origin is connected with the occurrence of amber-resin,

* I do not myself answer for the accuracy of this statement.—Dr. TH.

was decidedly negatived, since all these remains, as well as the great masses of coniferous wood, which are found near them in a fossil state, when carefully heated, developed no odour of amber. The circumstance that I found some fragments of wood which exhibited this odour could not prevent the separation of that flora from the amber, inasmuch as a notion has been developed respecting the occurrence of the lignite and fossil wood which accompany the amber, according to which remains of the true amber-fir decidedly differing from those forms may occur casually amongst them. In contradiction to the view which arose necessarily from a strict examination of the coast of Samland, the present occurrence of amber and lignite in general was referred to those causes in consequence of which the land in which they lie must be regarded as the alluvial product of some recent epoch in the formation of the world. It was supposed, that before the present epoch, at the period subsequent to the formation of chalk, when the molosse* was precipitated, and contemporaneously with it the Galician salt-beds were formed, an island to the north of the present Samland, covered with amber-forests, was protruded from the sea, and in the course of many myriads of years, under the influence of very active vegetative powers, the immense masses of amber were produced which for centuries have with equal abundance afforded a never-failing mine. When this amber-forest yielded to the catastrophe through which the figure of the continents and the forms of the organisms of the animal and vegetable kingdom originating on them were stamped with new characters, the primary resting-place of the amber must have been formed in and about that forest, and have been sunk with it into the bed of the East Sea, yet not so deep that it could not be exposed by subsequent catastrophes. If these consisted of powerful waves, and by the help of partial elevations and depressions different portions came successively into the sphere of operation, it could not fail that masses of amber would be washed out of them and be imbedded again in secondary beds, in a way which could be effected only by moving bodies of water. They were either washed out on the neighbouring shores which were undergoing great changes, and mixed with other rejectamenta of the sea must have formed the veins of amber answering to what are called the coast-seams (*Küstensäumer*) and the nests of amber corresponding with the casual hollows, or in consequence of stronger currents have been strewed in seeming confusion at a great distance from their birth-place, so that their principal deposits are arranged in lines, which, converging to one point, indicate the position of the original amber-forest.

* The exact equivalent of this term is doubtful. See Lyell, *Geol.* vol. iv. p. 140.

This view so immediately follows from the conviction of the alluvial nature of the district, a fact recognized in the name by which it is known, that it can be met only by new facts, except we have recourse to mere vague abstractions. The amber might thus be washed together, not only with the lignite to which it bears no relation, but amber-wood might also have been brought to the same place; and should this occur accidentally in the neighbourhood of other carbonized remains of plants, it would not lead to the conclusion, that these also belong to the amber-formation.

It can scarcely be doubted that mighty waters have acted on the southern shore of the Baltic. Whether the change which the surface must have undergone may have arisen principally from an influx or efflux of matter, is a question the answer to which is surrounded by very great difficulties. The blocks of granite, which in such immense numbers cover many tracts of the coast, cannot well be regarded as an argument for the influx. A stream of water capable of rolling such masses hundreds of miles over the hills and valleys of its bed would have bared the plain of Europe to its very ribs of rock, and had it brought matter for new deposits of such enormous size, those blocks of granite would at any rate have been the lowest. They lie however in the most wonderful manner on the most recent surface of the ground, a plain proof, as it should seem, that they were not moved on the ground by those waves, but being inclosed in masses of ice floated with them, and so were deposited on the surface on the melting of the ice. If they owe their present position to such a phænomenon, this is not contrary to the supposition that the diluvial stream in general has not affected the continent by destroying and washing out, any more than the admission that the rows of hills which now traverse it owe their origin to the influx of matter necessarily attending that deluge. For if the ground presented an unequal resistance to the rushing diluvial stream, whirlpools must have been formed, which, the stronger and more numerous they were, must have caused by their opposition relatively quiet tracts, as is plainly enough indicated by the hills which still remain, and by their peculiar form. We must admit that these alluvial heaps were first formed when the diluvial waves had for the most part completed their work of destruction, and in consequence of the necessarily decreasing energy of their motion gave a compensating deposit to the ground, which perhaps bore a very small proportion to the masses which were washed away from it. The question is not now as to the always progressing decrease of the land which was mentioned above, but refers to a much more important change of the surface by which the tract, many miles in breadth, was affected,

which many thousands of years since may have stretched northward into the East Sea.

I am speaking indeed of the small tract only of the Samlandic coast of the East Sea, with which I believe that I am sufficiently well acquainted to venture to make the assertion, that there can be no question as regards it of any remarkable diluvial deposit, or more recent alluvial formation. In many places, as for instance near Rauschen, this coat of tertiary soil is altogether wanting, and the winds sport with a snow-white sand which streams forth from the apertures of a thin clay, which is frequently black with fragments of lignite.

The masses, which rise to the height of a hundred feet or more out of the sea, are no diluvial refuse whose component parts are only accidentally thrown together; they are no remains of the coast of a constantly retreating sea, but a peculiar formation of a former epoch of the earth, driven from its original position by circumstances which have nothing to do with the phænomena of the deluge, owing rather their present state to a partial and probably not very remarkable upheaving of the soil.

If we follow the seemingly horizontal strata of sand and coal-bearing clay, which reach from Lapöhn to Warnik, and which are clearly an alluvial product belonging to that formation, we find between Warnik and Grosskuhren a peculiar sand-formation rising from the surface of the sea, and inclining at an angle of about 15 degrees to the west. It is formed of distinct parallel layers whose limits are defined by strong deposits of red ochre. These beds are frequently cut through in a vertical direction by tubular bodies, which remind one forcibly of the stems of Encrinites. Cup-shaped and reniform concretions of clay, red ochre and flint follow the parallel divisions, and in these and near them are found numerous marine fossil remains, which in part by their position indicate those beds as their original place of abode, and as the former bed of the sea. The frequently beautifully preserved shells of these beings, which are sometimes changed into tender ochre, sometimes into silicate of iron as hard as steel, have in their mineralogical structure no resemblance either to the petrifications which belong to the limestone of the Jura, and which are not quite unknown to these districts, nor to those of the chalk, which, though especially existent here, are but rarely met with. The marine remains belonging peculiarly to the amber-formation are *Ostracites*, *Echinites*, *Spatangi* and other productions, whose forms seem to have been sufficiently preserved to facilitate a closer distinction of the species, and hence to determine the position of the amber-formation in the geological members of the Carpathian plain. But this member of that chain seems to have pretensions to the name of amber-formation;

for under this sand-bank, consisting of parallel layers and about twenty feet thick, extend in a similar direction the strata of mottled and blue amber-earth, streaks of sandy loam about two feet thick, which in consequence of their great abundance of amber are everywhere explored, where they rise sufficiently high above the surface of the sea. Under them is found the bed called Schluff, which is distinguished from the amber-beds merely by the absence of amber. Amber however is not wanting in the muscle-bearing bed of sand which lies above it, by whose concretions it is often surrounded as by a matrix, but always much worn by the atmosphere. In the subjacent loam-beds, which may be regarded as the primary amber-strata, it is mostly in a state little differing from its original condition. The dull surface which covers with a thicker or thinner layer the shining resin within, exists in pieces of copal and pine-resin, and cannot be ascribed to any action of the weather, or have been produced by the agency of decomposing substances which have acted for thousands of years. The dull bark investing amber, copal and other resins in their natural condition is a partial alteration which they undergo from the influence of the atmospheric oxygen soon after their production, and, except where something hinders the progress of this decomposition, it proceeds till the original structure is entirely deranged. Such is the case in the superficial strata of our present soil, in which the amber accidentally present is always highly decomposed, and such also in those beds of sand which form the capping of the primary amber-beds. As regards the occurrence of fossil vegetable remains in these strata, they are very scarce in the muscle-bearing sand. Carbonized wood is somewhat more frequent in the amber-beds, at present entirely coniferous, and probably of the same structure as in the beds near Rauschen. But while this coal belongs to the class of earthy lignite, the carbonized ligneous remains of the amber-beds exhibit rather the condition of anthracite. Extraneous marine remains seem not to be entirely wanting in these amber-bearing beds. Sharks' teeth especially have been dug at times from the amber-pits, known under the name of birds' beaks; and impressions of Echinites, now unfortunately lost, were collected by me in the Schluff of the amber-pits at Little Kuhren. Another specific character as it should seem of these strata is their surprising abundance in sulphurous salts, as recognized by the strong taste of ink and the efflorescence of those portions which have been long exposed to the atmosphere.

This member of muscle-bearing sand, spotted and blue amber-earth and Schluff extends at the above-mentioned angle of elevation under the villages of Great and Little Kuhren, where it rises from forty to sixty feet above the surface of the sea, and to the

profit of the miner exposes the amber-beds. The western extremity of this formation behind Little Kuhren is covered by the Wachbuden hills and the Brusterort Point, both probably diluvial structures. It crops out again from this superincumbent mass, so that the shore of Samland stretching from the north to the south exhibits a no less interesting profile of this formation. At Rosenorth the strata dip rapidly to the south, and are withdrawn from further observation. But at the same time this identical formation rises abruptly from the bottom of the sea to the south, so that the divided sections of the strata are covered merely by a bed of diluvial loam about ten feet thick. This circumstance, taken in conjunction with the sudden dipping of the first division, seems to make it inadmissible to consider the one bed merely as a continuation of the other, while on the other hand the perfect parallelism in the constituent parts of the new bed forbids us to consider it as anything else than the horizontally-deposited bed of the sea. A third, similarly constituted and still more recent member of the amber-formation stretches in the immediate neighbourhood almost horizontally in the coast-hills near Dirschkeim, and raises its amber-beds, which are not very productive, more than forty feet above the level of the sea. The immense bed of sand which covers these is firm white sand, in which the ochre is apparently not so frequent. A perfect examination of this more recent member of the amber-formation has at present not been made, though enough has been done to establish its existence beyond the basin of the East Sea; for it was known long since that beds of amber lie beneath its waves, as indeed appears from the abundance thrown up on the coast. With equal probability it is supposed that these original beds in consequence of a partial elevation of the soil, whose central point is to be sought for near the north-western point of Samland, were brought sufficiently near to the immediate action of the present sea to make those districts the principal source from which amber is derived. It is probable from the bountiful produce of the coast that the richest beds of amber lie in the deep strata of this formation. A storm of but moderate length and strength on the first day of the present year threw up within a very short space 800 pounds of amber. As little however can be determined on this head as on the masses of this formation, which may have been washed away by the diluvial waves to the southern part of the plain at the foot of the Carpathian or Sudectic mountains. The occurrence of amber in these parts cannot be explained till more perfect geological investigations shall have shown the impossibility of the existence there of primary amber-beds. I have seen too little of Sicilian amber to decide whether it is a distinct variety from that of East Prussia. The

small specimens which I have observed in the rich collection of Privy Councillor Hagen seem to indicate such a difference.

If then we allow the existence of an amber-formation which contains primary beds of amber of a greater antiquity than the secondary deposits scattered here and there, it would not therefore follow, that the lignite which is found in its neighbourhood must be regarded as a constituent part of this formation, and the more so, since the clay-beds which contain it cannot be so considered. They simply fill a depression in its neighbourhood, and we can merely conclude from the nature of the materials used in filling it as to their age, since not even the perfect absence of the characteristic blocks of granite clearly proves, that their origin is not referable to the diluvial formation. Since the smell of amber now and then exhibited by a piece of wood from these beds is considered as an insufficient proof that the mass of vegetable remains which occur there belongs to the amber flora, it seems difficult to discover any other proof. The change of vegetable fibre however by nitro-sulphuric acid into an explosive substance shows its possibility. A piece of this wood which exhibited no smell of amber was subjected to this treatment, and though it gave no useful explosive matter, it yielded as a secondary substance a sort of resin which reminded one strongly of the artificial musk produced from amber by nitric acid. In consequence of this observation, I induced Dr. Reich to submit a number of fragments of wood from the locality above-mentioned, which seemed to belong to different Coniferæ, to examination, with a view to ascertain whether they contained any succinic acid: the results surpassed all expectation. Of fourteen specimens, thirteen exhibited beyond all doubt the presence of this acid, which may reasonably be assumed as coming from the resinous constituents of the wood; the fourteenth, which belonged to *Taxites Aykii*, gave a crystallizable acid different from the other, which unhappily, by reason of the very small quantity of the wood examined, would not admit of further investigation. But not only these fragments of wood showed in this way their relation with amber, but the remains of fossil cones from the same beds gave a similar result, amongst which indeed no particular selection could be made, but they exhibited on the most careful trial no smell of amber. They, as well as the lignite which did not exhibit the well-known structure of the wood of conifers, yielded on destructive distillation fluids, in which the presence of crystalline succinic acid could be ascertained by the microscope and by chemical reagents. If then the occurrence of succinic acid except from amber is so problematical, that amber may be considered as its only source, we must admit also that coniferous woods which contain it belonged not only to the amber

flora, but that they were that portion of it which actually yielded it. The great variety in amber makes it not improbable that many amber-bearing conifers existed in the flora, and it is very conceivable that others coexisted which yielded no amber. Since the fragments submitted to examination were by no means especially chosen for this purpose, but were merely as perfect an assortment as circumstances allowed of the species of wood which occurred in the locality, it seems to follow, that the principal mass of the trees, to which the lignite owes its origin, is to be considered as belonging to the class of amber-yielding trees.

This result is certainly not without practical importance. For though the in general insignificant nests of lignite which are found in the beds of clay on the coast of Samland encourage no great hope of a remunerative harvest, yet its connection with such large quantities of amber makes it not improbable that still larger masses of this useful fossil will be found in other places of the South Baltic continent. It is not probable that the wreck of the amber-forest, as far as regards its timber, should have been reduced to these few remains; it is possible that the more important beds of lignite which must have originated from them may have been floated away by the diluvial waves on the destruction of the land, but even in this case strata of coal may still be found. In this respect every fact is important which gives a solution of the presence of lignite in these parts, should it but tend to direct greater attention to the subject. At present the number of these facts is very small. On occasion of boring for water near Balga, a bed of lignite was pierced at a depth of sixty feet beneath white sand, which by the structure of its coal and the fir-cones which came to view appeared to be perfectly identical with the coal-beds near Rauschen. Herr Rupson, who conducted the work and is to continue it, will certainly not omit to pay particular attention to this circumstance and to communicate the results of his labour. I believe a second trace of lignite has been found at Sarkau, on the sea side of the low ground, where a black bank of mould, which I took for lignite, and which seems mixed with very isolated coarse grains of sand, rises to the height of the sea-level. A third problematic trace of lignite as I believe is found in a bed of peat to the south of Heiligenbeil; about four feet deep a mass of lignite is deposited in undulated heaps. Did not an immense bed of undecomposed peat exist beneath it, it might be considered as the usual produce of turf-formation; but it appears to me probable, that the remains of a bed of lignite torn to pieces by waters are there deposited. Many beds of turf indeed, which like that at Balga and near Koppershagen present immediately on the surface a very com-

fact kind of fuel, which in texture reminds one forcibly of lignite, deserve further attention, especially as regards the fossil woods which are contained in them. I consider it not impossible that beds of lignite may be concealed under the form of such peat-beds, which on this supposition might, by proper draining and contrivances, yield a very valuable kind of fuel at an easy price. There has also been some rumour of traces of lignite in the construction of canals and railroads, which are too rare with us. It is to be wished that those persons who can make inquiries, and do not mind the trouble of stating the result of their labours, would choose some better medium of communication than perishable newspapers, where their communications can scarcely be found when wanted. The provincial reports will doubtless gladly promote inquiries of such general provincial interest.

XXXIX.—*On three species of Mould detected by Dr. Thomas in the Amber of East Prussia.* By the Rev. M. J. BERKELEY, M.A., F.L.S.

[With two Plates.]

IN the spring of the present year I received from Dr. Karl Thomas of Königsberg, who is perhaps better known as a metaphysician than as a naturalist, part of a large collection of sections of amber from East Prussia which consists of several hundred individuals. A large portion of the specimens transmitted contained unequivocal specimens of moulds, in most cases in the condition of mere mycelium, but in one or two instances in beautiful fructification and in a very high state of preservation. Of these he kindly sent some very beautiful and correct sketches, of which I have availed myself in the present communication.

The actual occurrence of fungi in a fossil state has hitherto been very problematical. In the extensive collection of fruits from Sheppey Island which formed the foundation for Mr. Bowerbank's work, I believe no undoubted instance of any parasitic fungus occurred, though *Sphaeria* and other fungi of a hard texture might reasonably have been expected in such a situation, and especially in so recent a formation. Dr. Brown has observed occasionally appearances in the cells of fossil wood which he has been inclined to refer to mycelium, though as I understand with no very decided opinion on the matter.

Dr. Göppert has figured, on a fossil fern belonging to the older coal-measures, what he considers a fungus under the name of *Excipulites Neesii*. I have not seen this figure, but the circumstances under which the vegetable remains which gave origin to the beds of coal must have existed, would not be such as would